

A PRELIMINARY ANALYSIS OF LONG-TERM CHANGES IN THE VALUE OF LANDINGS BY FRENCH FISHING FLEETS OPERATING IN THE NORTH-EAST ATLANTIC

Fabien Steinmetz, University of Western Brittany (fabien.steinmetz@ifremer.fr)
Olivier Thébaud, IFREMER, France (othebaud@ifremer.fr)
Olivier Guyader, IFREMER, France (oguyader@ifremer.fr)
Fabian Blanchard, IFREMER (fabian.blanchard@ifremer.fr)

ABSTRACT

Recent work in the domain of fisheries ecology has shown that major changes are occurring in fish communities exploited by commercial fisheries. Selective fishing pressure on more highly valued components of fish communities, and its indirect effects via trophic interactions, are amongst the key factors proposed to explain these changes. Under de facto open access conditions, it is suggested that sequential overharvesting of higher valued fish and/or fish species leads to modifications in the structure of both fish communities, and fisheries landings. An important question is the implication of such changes in terms of the total value of landings from a given fish community.

The aim of this paper is to present a preliminary analysis of this question in the context of French commercial fisheries. The analysis focuses on trends observed in the landings of fishing fleets operating in the North East Atlantic, over the last three decades. It is based on data concerning annual quantities landed and prices of 85 species, compiled by the authors from French official landings records. Changes in total quantity and total value landed are presented, as well as changes in the structure of landings in terms of the ecological characteristics of species landed. Using the economic theory of index numbers allows to separate volume and price variations, and to analyze their respective contributions to variations in gross turnover. Key drivers of these variations are then discussed.

Keywords: long term trends in landings, catch composition, price fluctuations, ecological impacts of fishing and climate change

INTRODUCTION

Recent work in the domain of fisheries ecology has shown that major changes are occurring in fish communities exploited by commercial fisheries (Pauly et al., 1998). Selective fishing pressure on more highly valued components of fish communities, and its indirect effects via trophic interactions, are amongst the key factors proposed to explain these changes. Under de facto open access conditions, it is suggested that sequential overharvesting of higher valued fish and/or fish species leads to modifications in the structure of both fish communities, and fisheries landings. An important question is the implication of such changes in terms of the total value of landings from a given fish community. Sumaila (1998) presents an analysis based on FAO marine fisheries catch data collected from all fishing nations for 1950 to 1996 for over 1000 species of fish. Based on a classification of fish into either high or low trophic level species, the author observes the shift in the proportion of total world catches towards more catch of low trophic level species relative to high trophic level species, and suggests that this entails differences in the evolution of relative prices between the two groups of species. Pinnegar et al. (2002) use this assumption to develop a model of how the relative price of species located at different trophic levels in a fish community should evolve with increasing fishing pressure. According to these authors, the increase in fishing pressure on species with high trophic levels entails a rarefaction of these species on markets, leading to an increase in their prices, relative to those of low trophic level. This entails substitution effects

with consumers increasing their demand for lower trophic level species, thus leading to increased fishing pressure on the latter and an increase in their price due to their ensuing rarefaction. As a consequence, what they name the “relative price index” of high versus low trophic level species stabilises. Further increases in fishing pressure lead to the commercial extinction of high trophic level species due to their scarcity, while increasing the pressure on low trophic level species, hence the relative price index starts decreasing. Based on their analysis of long term changes in the Celtic Sea fish community and fisheries, the authors show that there has been a decrease in the mean trophic level of catches, and an increase in the relative price index of high versus low trophic level species between the late 1970ies and 2000, thus confirming that the former have become relatively more expensive relative to the latter over the study period.

In this paper, we present a preliminary analysis of the changes observed in the landings of French commercial fleets operating in the North-East Atlantic. The analysis is carried out as part of a research project looking at the interactions between fisheries, climate change, and the evolution of fish communities on a decadal scale¹. The objective is to provide a first description of the trends observed in the quantities of the different species landed by French fleets operating in the North-East Atlantic, as well as their prices, and the resulting total value at first sale of landings by these fleets. Including the biogeographical characteristics of species landed also allows to describe changes in the composition of landings, and to establish whether some of the changes observed elsewhere can also be observed in the fisheries prosecuted by French fleets. This also allows discussing some of the assumptions made in the literature concerning the economic drivers and the economic implications of modifications in the composition of landings.

The paper is structured as follows. The first section presents the data collected and the methodology used to construct indicators of trends in landings by the French fleets operating in the North-East Atlantic over the 1973-2002 years. The second section presents a descriptive account of these trends, as well as an assessment of the contributions to overall changes in the value of landings of prices and quantity changes. The third section discusses these results in the light of the recent debates on the economic causes and implications of modifications in the ecological composition of fisheries landings.

DATA AND METHODOLOGY

The study is based on data collected from two main sources. Statistical records published by the French Central Committee for Marine Fisheries (“*Comité Central des Pêches Maritimes*”) for years 1973-1990 were used for annual data for those years. Annual statistical records published by the National Office for Sea and Aquaculture Products (“*Office National Interprofessionnel des Produits de la Mer et de l’Aquaculture*”), the French Marine Fisheries and Aquaculture Directorate (*Direction des Pêches Maritimes et de l’Aquaculture*) and the Central Committee for Marine Fisheries were used to collate the same information for years 1990-2002.

Based on these two sources, which use the same codification of species, a list of 73 species was identified, for which annual landings and average annual prices at first sale for the French metropolitan fleets were collated. This included information for fleets operating both in the North-East Atlantic and in the Mediterranean. Given the objectives of the study, it was necessary to exclude Mediterranean landings from the data set. This was done using the information available in the statistical records, when information was available on the allocation of landings between the different marine areas. When this information was not available in the documents, FAO statistics were used to estimate the proportion of French metropolitan landings per species which originated from the North-East Atlantic, and this coefficient was applied to the annual total landings of the species concerned. For recent years (after

¹ The “CHALOUPE” project focuses on global change, dynamics of exploited marine biodiversity, and the viability of fisheries. It is funded by the French National Research Agency, over the period 2006-2008 (<http://www.projet-chaloupe.fr/>)

1990), cross-checking with other data sources was carried out, for several key species. Current prices were converted to constant prices using the French consumption price index produced by the National Institute for Statistics and Economic Studies (« *Institut National de la Statistique et des Etudes Economiques* »), using year 2001 as the base year.

Despite the different verifications which were carried out to ascertain the quality of the data set, several sources of bias in the information used must be taken into account when considering the results of the analysis. First, with the implementation of the Common Fisheries Policy, a system of price support was established, which involves the application of minimum prices at first sale for certain species, under which landings are subtracted from sale. This may imply downwards biases in the average prices recorded in the official statistics used here, which are usually limited at the annual level, but can be significant at a finer scale. Difficulties related to the monitoring of total catches must also be taken into account. First, an unknown part of the catches is discarded at sea, hence is not included in the landings statistics. Second, only approximately half the annual landings of French fleets are sold via auction markets. While there is good statistical coverage of these sales, those occurring via other market channels are more complex to monitor, with a possibility that part of the annual landings concerned go unrecorded. This implies that statistics considered in this analysis, while interesting to describe global trends, may be more susceptible to bias when considering particular species, especially those that are known to sell outside auction markets, and should thus be considered with care. Finally, there is a possibility that regulations applying to fisheries may have led to biased declarations of landings for certain species.

In order to assess changes in the composition of landings by species groups, information was also collected from Fishbase (<http://www.fishbase.org/>) and from the literature regarding the bio-geographical characteristics of species landed. Indicators used included the trophic level of species, their maximum length, and the median depth, latitude and longitude of the areas over which they are known to distribute. Thirteen groups of species were also identified based on their ecological characteristics.

In order to establish a synthetic view of the trends observed in the data set, an aggregation of the information available for the 73 species was required. This was done by calculating standard indices used in the economic analysis of changes in production and consumption. Fisher indices for quantities and prices were calculated, for all species, and for species groups as defined based on ecological criteria (see appendix). This allowed calculation of the contribution of total variations in prices and quantities landed to total variations in gross turnover of the fleet. Simple indices of the average bio-geographical characteristics of landings were also calculated.

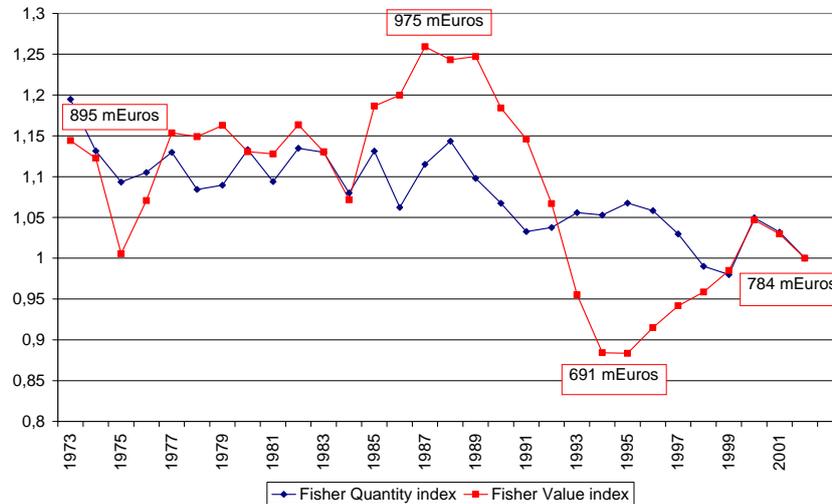
RESULTS

Trends in the production of French fleets were considered first globally, and second in terms of the composition of landings.

Trends in global production

First, we present the trends observed in the volume and value of landings of the entire set of species included in the data set. This is illustrated in figure 1 below, using index values.

Figure 1 – Evolution of Fisher indices of total landings in volume and in value by French fleets operating in the North-East Atlantic, 1973-2002 (2002 fixed base)



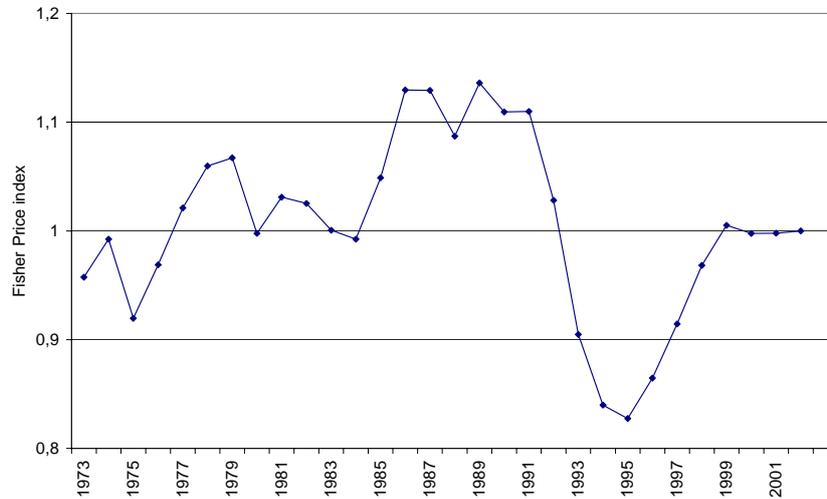
Source: Ifremer, based on *CCPM-OFIMER-DPMA* data

Over the past thirty years, total tonnage of fish landed have decreased, from 440 000 tonnes in 1973 to 380 000 tonnes in 2002, with most of this decrease taking place from the early 1980ies onwards. The decreasing trend of 1 000 tonnes per year is significant, despite a certain degree of inter-annual variability. The value of total landings shows a more contrasted evolution. Following a period of relative stability, total value tends to increase in the late 1980ies, reaching a maximum in 1987. It is then severely reduced in the early 1990ies, and increases again from 1995 onwards. In 2002, the total value of landings is however lower by approximately 100 million euros 2001 to its level in 1973.

This long-term variability in the total value of landings is strongly related to changes in market conditions under which French fishing fleets have operated over the study period, as is illustrated by the evolution of the Fisher price index in figure 2 below. Four distinct periods can be identified in this time series: (i) a period of limited increase in prices between 1973 and 1985; (ii) a period of strong increase in prices between 1986 and 1991; (iii) a period of price collapse in 1993 and 1994; and (iv) a new period of strong price increase in the following years, leading fish prices back to a level similar to that which was observed thirty years ago.

There thus appears to have been a structural shift in the conditions under which the French fishing fleets operate. Until the early 1990ies, stagnation first and then reduction in the total tonnage landed led to more or less strongly increasing prices, sufficient to entail an increase in the total value landed. Following the market crisis of the early 1990ies, which can be related to the liberalisation of trade in fish products on the European markets and to the development of competition on the markets on which the fleets operate, the continued decrease in tonnage landed was associated to a strong increase in prices, leading to the renewed growth of total gross turnover. However, due to both lower quantities landed and lower prices than in the late 1980ies, it has not been possible to recover the levels of production observed in those years.

Figure 2 – Evolution of the Fisher price index for landings by French fleets of 73 species, 1973-2002 (2002 fixed base)



Source: Ifremer, based on *CCPM-OFIMER-DPMA* data

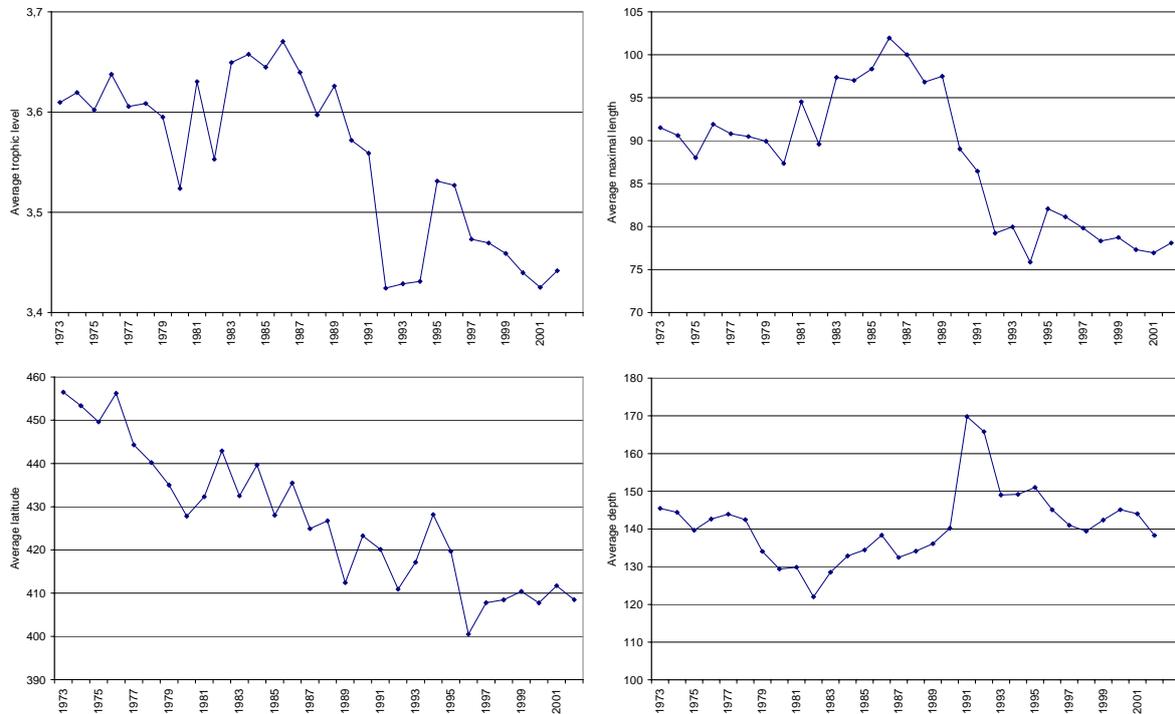
Using the methodology developed by Chevalier (2003), and the chained version of the Fisher indices, contributions of cumulated changes in the price and quantities landed of each species, to total changes in gross turnover derived from landings were calculated. Cumulated variations in prices contributed to 56.5% of total changes in revenue of the fleet over the study period, while 43.5% of changes in revenue were due to changes in volumes landed.

Trends in the composition of production

Figure 3 below illustrates the evolution between 1973 and 2002 of: (i) the average trophic level of the landed species (top left); the average value of maximum length of the landed species (top right); the average value of median latitude of the area over which landed species distribute (bottom left); and (iv) the average value of depth of the area over which landed species distribute (bottom right).

Following a period of high and relatively stable average trophic level of the species landed until the mid 1980ies, a marked decrease in this index is observed. In particular, the years of market crisis are marked by a significant drop in the mean trophic level of species landed, indicating a marked change in the composition of landings in response to price collapses, with an increase in the share of lower trophic level species. Following recovery in the mid-1990ies, the index continues to decrease until the end of the study period.

Figure 3 - Evolution of the average bio-geographical characteristics of landings by French fleets, 1973-2003



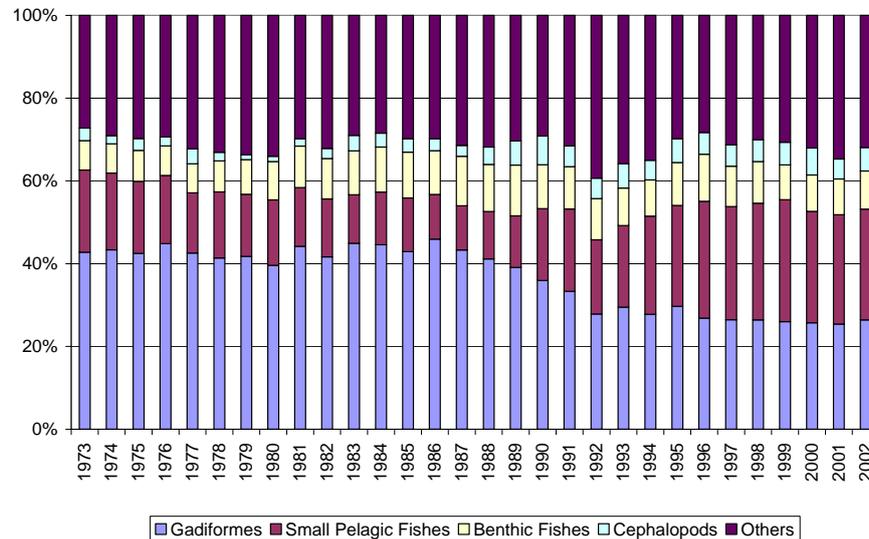
Source: Ifremer, based on *CCPM-OFIMER-DPMA* data

Other indices calculated also illustrate the modifications which have occurred in the composition of landings throughout the period. The evolution of the maximum length index over the study period shows a trend comparable to that of the trophic level index: following a period of increase until the mid 1980ies, it decreases steadily, with a particularly strong drop in the market crisis years, and a continued decline following recovery from this crisis. The latitudinal index provides indications as to the potential influence of changes in climate on the fisheries in which French fleets operate. Species landed by these fleets distribute around latitudes comprised between 39° and 46° North. The average latitudinal index calculated for landings of French fleets shows a decreasing trend, on the order of 0.17° per year, indicating that the proportion of warm water species in French landings has increased over the study period. The mean depth index illustrates the development of fisheries for deep water species in the 1980ies, and their decrease in terms of contribution to total landings in the last decade.

Evolutions by group of species

Figure 4 below illustrates the changes observed in the composition of landings, using ecological characteristics to define the following groups of species: gadiformes, small pelagic fishes, benthic fishes, cephalopods and other species.

Figure 4 - Evolution of the landings in volume by French fleets, per ecological group of species, 1973-2002



Source: Ifremer, based on *CCPM-OFIMER-DPMA* data

The contribution of small pelagics to total volumes landed by French fleets has shifted from less than 20% in 1973 to more than 25% in 2003. Cephalopods have known a similar increasing trend. In the meantime, the contribution of gadiformes, a group which includes several key commercial species targeted by the fleets, has shifted from more than 40% to less than 25%. Similar reductions have also been observed for crustaceans, which include several high value species. The largest part of these changes has occurred between the mid-1980ies and the mid-1990ies. Other groups which include higher value species, such as benthic fish, have known an increase in their contribution to total landings in volume during those middle years, followed by a decrease in the latest part of the study period. A succession of species targeted by French fleets thus appears to have occurred during the study period. Preliminary results of a comparison of the changes observed in landings with those observed in independent survey data (Blanchard et al., 2005) suggest that this succession reflects changes in the composition of the fish communities on which French fleets fish. However, it is also apparent that modifications in the composition of landings can be attributed to changes in fishing strategies, in response to changes in the conditions under which fleets operate. For example, the drop in the trophic index and maximum length indices observed in the mid-1990ies clearly relate to changes in the fishing strategies in response to the market crisis, with an increase in the quantities landed of species at lower trophic levels.

DISCUSSION AND CONCLUSION

The data collected allows a preliminary description of the evolution of total landings by French fleets operating in the North East Atlantic, over the last three decades. Since 1973, total landings in both volume and value have decreased. Changes in the total value have been strongly influenced by changes in fish prices. These changes have largely resulted from external shocks on the market affecting the competitiveness of French fisheries production, but may also be related to modifications in the structure of landings in terms of quantities of the different species landed. It also appears that the modifications in landings composition observed can be related to changes in fishing strategies in response to external perturbations, as illustrated by the market crisis of the mid 1990ies, which led to increased landings of lower trophic level species. A more detailed analysis of the factors driving these changes is underway.

The relative price index of landings, as defined by Pinnegar et al. (2002), was calculated for 37 fish species landed by the French fleet. There appears to be an increase in the value of the index over the study period, comparable in intensity to that observed by these authors over a similar period. This would support the idea that the prices of higher trophic level fish species have increased relative to those of lower trophic level species. Care should however be taken in interpreting this result, as a number of difficulties were encountered in the analysis. In particular, one of the main difficulties lies in the limited strength of the relation observed between the trophic level of species and their average annual price in any given year. Results supporting the assumption that higher trophic level species fetch relatively higher prices than low trophic level species were obtained only for fish species, and even for those, the relationship observed is weak.

The results of this preliminary analysis show that further investigation is warranted as to the factors which influence the differences in the relative prices, and relative price trends of fish species landed by French fleets. In particular the extent to which these can be related to ecological differences in species requires more refined empirical work. Further analysis should also be carried out regarding the other drivers of differences in the evolution of prices of different species over the study period, in particular due to changes in market conditions. This analysis will be carried out in the next stage of this research.

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APPENDIX – INDEX CALCULATIONS

Define p_{it} the price of species i at time t and q_{it} the quantity landed of species i at time t . The following indices can be calculated for different groupings of the species included in the landings database.

Laspeyre price index:

$$\text{Fixed base: } L_{t/0}^p = 100 \cdot \frac{\sum_i (p_{i,t} \cdot q_{i,0})}{\sum_i (p_{i,0} \cdot q_{i,0})}; \text{ chained: } L_{t/t-1}^p = 100 \cdot \frac{\sum_i (p_{i,t} \cdot q_{i,t-1})}{\sum_i (p_{i,t-1} \cdot q_{i,t-1})}$$

Laspeyres quantity index:

$$\text{Fixed base: } L_{t/0}^q = 100 \cdot \frac{\sum_i (p_{i,0} \cdot q_{i,t})}{\sum_i (p_{i,0} \cdot q_{i,0})}; \text{ chained: } L_{t/t-1}^q = 100 \cdot \frac{\sum_i (p_{i,t-1} \cdot q_{i,t})}{\sum_i (p_{i,t-1} \cdot q_{i,t-1})}$$

Paasche price index:

$$\text{Fixed base: } P_{t/0}^p = 100 \cdot \frac{\sum_i (p_{i,t} \cdot q_{i,t})}{\sum_i (p_{i,0} \cdot q_{i,t})}; \text{ chained: } P_{t/t-1}^p = 100 \cdot \frac{\sum_i (p_{i,t} \cdot q_{i,t})}{\sum_i (p_{i,t-1} \cdot q_{i,t})}$$

Paasche quantity index:

$$\text{Fixed base: } P_{t/0}^q = 100 \cdot \frac{\sum_i (p_{i,t} \cdot q_{i,t})}{\sum_i (p_{i,t} \cdot q_{i,0})}; \text{ chained: } P_{t/t-1}^q = 100 \cdot \frac{\sum_i (p_{i,t} \cdot q_{i,t})}{\sum_i (p_{i,t} \cdot q_{i,t-1})}$$

Fisher price index:

$$\text{Fixed base: } F_{t/0}^p = \sqrt{L_{t/0}^p \times P_{t/0}^p}; \text{ chained: } F_{t/t-1}^p = \sqrt{L_{t/t-1}^p \times P_{t/t-1}^p}$$

Fisher quantity index:

$$\text{Fixed base: } F_{t/0}^q = \sqrt{L_{t/0}^q \times P_{t/0}^q}; \text{ chained: } F_{t/t-1}^q = \sqrt{L_{t/t-1}^q \times P_{t/t-1}^q}$$

with the product of the Fisher indices of price and quantity changes equal to a simple index of changes in the total value of landings.